exceeds 8 lines (17 millim.). One specimen inhabited a shell of a species of *Clavatula*.

I cannot regard the distinctions mentioned by Heller as characteristic of *E. meticulosus* as of specific importance.

The smallest specimen in the collection referred to this species—length of carapace not 3 lines (6 millim.)—has the outer surface of the palm in the larger chelipede much more evenly granulated and the median longitudinal ridge obsolete, and bears a great resemblance to *E. Forbesii*, Heller, of which there is an authentically named specimen from Falmouth (*W. P. Cocks, Esq.*) in the Museum collection, which may be nothing but the young state of this species. I hesitate, however, to unite the two without further comparison of a larger series of specimens. A much larger example from Sicily, in the Museum collection, designated *E. Forbesii*, has the outer surface of the larger chela armed with numerous spines, and without depressions or longitudinal ridges, and is probably referable to *E. Lucasi*, Heller (=*E. spinimanus*, Lucas).

Besides the Paguridæ enumerated above, there is in the collection a very small hermit-crab, apparently of the genus *Cibanarius*, inhabiting a shell of *Nassa miga*, Adanson, which it would be unadvisable to designate by a distinct specific name.

[To be continued.]

XXVII.—Dr. H. Adler's * *Researches on the Alternating Generation of the Gall-flies of the Oak.*

"A satisfactory explanation of the mode of reproduction of the Cynipidæ will only be obtained when their development is traced step by step, through all its stages, from the fertilized and unfertilized egg. Let us hope that amongst our entomologists an Œdipus will be found able to solve this enigma."

It was thus that Prof. von Siebold expressed himself in the last chapter of his work upon parthenogenesis, published ten years ago. The Œdipus has appeared, and has furnished us with one of the most curious chapters in the history of insects.

It has been known for a long time that in many species

* Translated by W. Francis, jun., from the 'Bibliothèque Universelle de Genève' for June 15, 1881.

of gall-flies the males are much less numerous than the females; among certain of these Hymenoptera they appeared even to be altogether absent. Several hypotheses had been put forward to account for these anomalies. It is useless to recall them here, as they have disappeared before the results of observation. It was eight years ago that the first true notion of the phenomena of the reproduction of these insects was introduced to science. In 1873 Mr. Bassett published in the 'Canadian Entomologist' some observations upon gall-flies, amongst which was one of great importance. He demonstrated that one species living on *Quercus bicolor* produced upon the peduncle of the leaf and upon its median nervure swellings whence emerged, in the month of June, insects among which the male sex and the female sex were represented in equal numbers. Galls of another form appeared at the end of summer upon the extremities of the young branches; the insects which were developed in their interior and hibernated there were all females, differing only from those of the preceding generation in being slightly larger. Mr. Bassett concluded from these facts that the two generations proceeded one from the other, and succeeded one another in the course of a year. Although based on a bare supposition and wanting in direct proofs, this theory has been verified by the observations of M. Adler of Schleswig, who, in 1875, began his numerous and persevering researches without being acquainted with the opinions of the Canadian entomologist.

The investigations of M. Adler extended to all the species of oak-gall-flies which he has been able to observe in his native country, North Germany. He took the greatest pains to follow the various phases of development of each species, and the successive forms in which it appears. The description of the methods employed in the rearing inspires absolute confidence in the results.

M. Adler divides the Cynipidæ of the oak into four groups, which include all the species observed by him, viz.:—

I. Group *Neuroterus*;

II. Group *Aphilotrix*;

III. Group *Dryophanta*;

IV. Group *Biorhiza*.

The insects belonging to the first of these groups may furnish us with an instance of the singular phenomena of reproduction discovered by M. Adler.

Neuroterus lenticularis produces, on the under surface of the

leaves of the oak, galls which appear in July and fall to the ground in September or October. The larva is at this period very small; and the perfect insect does not come out till April or the beginning of May. Scarcely has it escaped from the gall in which it was developed, when it deposits its eggs upon the buds of the oak. Around these eggs are formed, upon the leaves and the peduncles of the male flowers, galls differing from those which had nourished the *Neuroterus*. The insect which emerges from them is no *Neuroterus* at all, but had been classed in another genus under the name of *Spathegaster baccarum*, L. This, in its turn, will deposit eggs which will produce *Neuroteri*.

The same alternation has been observed in three other species of *Neuroterus* corresponding to three distinct species of *Spathegaster*.

Not only do the two generations live in galls differing in form, size, colour, and situation, and the insects exhibit among themselves differences of size, proportions, and structure, but what renders the contrast more striking is, that *the* Neuroterus *generation is only represented by females, whilst the* Spathegaster *generation presents individuals of both sexes.* We have therefore here a new form of alternating generation*.

The genus *Aphilotrix* contains a great number of species of Cynipidæ, of which only the female individuals were known. M. Adler observed in nine of these an agamic and sexual alternation of generations; these last are represented by species belonging to the genus *Andricus*.

Three species of *Dryophanta* which were investigated by the same observer exist only in the female state; the succeeding generation is formed, as in the case of *Neuroterus*, of species belonging to the genus *Spathegaster*.

The fourth group, that of the *Biorhiza*, is the most interesting of all, on account of the differences of form and habits which the insects of the two consecutive generations exhibit.

Biorhiza aptera, which exists only in the female form, is a little wingless insect, from 4 to 7 millim. long, known to form upon the roots of the oak galls at first soft and of a reddish-white colour, which assume a brown colour on arriving at maturity, and become tolerably solid. M. Adler observed that the insect which comes out from them does not lay its eggs on the roots, but climbs the oak to attack the young shoots, and, above all, the big terminal buds. From the galls which are developed round the punctures an insect comes out,

* This case belongs to the category which Prof. Balfour, in his treatise on embryology, calls heterogamy.

which had received the name of *Teras terminalis*. This second form includes winged males, and females either wingless or furnished only with the rudiments of wings. In other respects the two generations do not differ much in the totality of their organization.

In another species of the same group, *Biorhiza renum*, the differences of structure between the two generations are far more striking. This insect (the agamic generation) is wingless, 1·5 millim. long; its abdomen is sessile. Its antennæ have thirteen joints, its labial palpi two, its maxillary palpi four. From its eggs, deposited on the adventitious buds of the trunk, branches, or twigs, emerge, at the end of May or middle of June, a Cynips known under the name of *Trigonaspis crustalis*, and which differs very much from the preceding. It is 4 millim. in length; the male and female are both provided with very long wings. The antennæ of the male have fifteen joints, those of the female fourteen; the labial palpi have three joints, the maxillary five. The colour and the sculpture of the body are very different from what is seen in *B. renum*. The ovipositor has also quite a different structure.

In the species of these four groups, the transformations of which we have just traced from the observations of M. Adler, there is a cycle formed of two generations more or less distinct one from the other—one of which is represented only by females laying by parthenogenesis, while the other exhibits both sexes. This alternation, although very much diffused amongst the Cynipidæ, is not the general rule. There are some *Aphilotrices* which reproduce in a continuous way without any males appearing. The four species in which M. Adler has observed this mode of reproduction emerge in April, and have only one generation, of which the period of development is a year.

The galls which furnish food and shelter to the Cynipidæ during the greater part of their existence, as is known, vary considerably in form, colour, size, and situation. They furnish good characters for distinguishing species which are otherwise difficult to separate.

It has been generally supposed that it is the puncture of the gall-flies, with the introduction into the wound of a secretion peculiar to the insect, which causes an irritation and, in consequence, an abnormal production of cellular tissue. On this hypothesis the differences between the galls are to be explained by the variety of the substances produced in the glands of the insect and deposited in the tissue of the plant. M. Thomas, of Ohrdruf, who has examined a great number of galls of insects and Acari, had already called in question this

explanation. M. Adler, on the other hand, proves its falsity as regards the galls of the Cynipidæ of the oak. At the same time he admits that it holds good in the case of certain galls which owe their existence to other Hymenoptera. Thus, the wound made by the serrated ovipositor of *Nematus Vallisnierii* in the leaves of *Salix amygdalina* causes an abundant formation of cells; and the gall thus formed attains its full growth at the end of a few days, before the larva has escaped from the egg. In the *Cecidomyiæ*, on the contrary, the manner in which the eggs are laid shows clearly that it is the larva which causes the formation of the gall. The same is the case with the Cynipidæ. No effect is produced until the larva is hatched. *Trigonaspis crustalis* lays its eggs in May, and the larvæ do not hatch till September; and it is only in this last month that the gall begins to form. As soon as the larva has attacked some cells the increase is effected. M. Adler has even proved that whilst the young larva has the hind part of its body still enclosed in the membrane of the egg, a large proliferation of cells is formed in front of it round the slightly wounded tissue. M. Adler gives many particulars concerning the regions of the tree and the nature of the tissues in which the galls are developed, and concerning the causes which lead to anomalies or arrests of development of these galls. [Two coloured plates very well executed represent the galls mentioned in the memoir.] The author describes and figures with care the parts of the ovipositor, and discusses the manner in which the egg is probably introduced to the further end of the canal pierced by the insect.

The eggs of the gall-flies differ from the pedicellated eggs of other Hymenoptera in so far that in the latter the pedicel is placed at the anterior pole of the egg instead of at the posterior. Moreover this extension is not a simple solid appendage of the envelope of the egg of cuticular nature. It contains a cavity which is in direct communication with the vitelline cavity; and its extremity presents a club-like swelling. M. Adler is of opinion that this pedicel, which is exposed to the atmosphere, performs the part of a respiratory tube.

We have already pointed out above some of the essential characters which distinguish the two generations in certain Cynipidæ. The distinction is far from being always so striking as that which is observed in the group *Biorhiza*. The species of *Neuroterus* and *Spathegaster* do not exhibit externally much difference; but on examining them more closely it is seen that the *Neuroterus* form is thicker set and has the abdomen more strongly developed, the wings shorter

and broader, and the antennæ longer than the *Spathegaster* form. The differences which are perceived in the abdomen are due to the structure and form of the ovipositor, which vary according to the duty it is called upon to perform and the part which it is destined to pierce.

The reproductive organs seem to have on the whole the same structure in the females of the two generations. In both the ovaries are formed of a great number of ovarian tubes, in each of which are found from six to twelve eggs. Generally the agamic generations have a greater number of ovarian tubes, and there are more eggs in each tube. One gland, which M. Adler regards as playing the part of a prostate, although more developed in the females of the sexual generation, exists also, however, in those of the agamic generation. What is still more remarkable is that *the seminal receptacle is found not only in the females of the agamic generations which alternate with the sexual generations, but also in those of the species which propagate only by parthenogenesis.* A certain degree of atrophy of this organ is found, however, among the agamic females in comparison with that among sexual females. The persistence of the seminal receptacle in these parthenogenetic insects plainly shows, as M. Adler remarks, that at a very remote period males must have existed. Other facts described by the author tell the same tale. There is found, moreover, among the Cynipidæ (*Rhodites rosæ* and *R. eglanteriæ*) living on other plants than the oak a manifestation of atavism, thus confirming the bonds which exist between the sexual and agamic states. Although reproduction among them has become entirely parthenogenetic, yet at times males appear, although probably no copulation has taken place for a long period.

Besides the differences existing between the perfect insects, the two alternating generations are distinguished also by the longer or shorter time necessary for the development of the egg and of the larva, and by the division of the phases of this development. The larvæ of *Neuroterus* and those of *Spathegaster* also exhibit differences in the form of their mandibles, these organs being adapted to the kind of life of each.

The researches of M. Adler have not been merely limited to the Cynipidæ of the oak. Other Hymenoptera, parasitic on animals and plants, have disclosed to him some interesting facts, which show to what a great extent parthenogenesis prevails among the insects of this order, and under what different conditions it shows itself in the various groups, and even in the species of the same genus.

Von Siebold proved that in *Nematus ventricosus* the males

and females are in equal numbers, and that nevertheless parthenogenesis exists. M. Adler has observed the mode of reproduction of *N. Vallisnierii*, and discovered in this species the existence of two broods a year which are entirely parthenogenetic; so that parthenogenesis, which is only exceptional in the first species of this genus, has become constant in the second.

Pteromalus puparum, the larva of which lives as a parasite in the chrysalides of various species of diurnal Lepidoptera, also exhibits phenomena of parthenogenesis; but the consequences of this mode of reproduction are the inverse of those which are observed in *Nematus Vallisnierii*. Thus the virgin females chiefly give birth to males, a fact which brings these insects near to the bees as regards their reproduction. Of four chrysalides infested with larvæ of this *Pteromalus* produced by parthenogenesis, the first yielded 124 males, the second 62 males, the third 75 males and 5 females, the fourth 45 males and 4 females.

All these facts tend to prove that parthenogenesis among the Hymenoptera originates from sexual generation. It is, apart from that, difficult to establish any general law, because the results relative to the sex of the progeny are too changeable. Sometimes the virgin females give birth principally or exclusively to females, sometimes to males and females in apparently equal numbers, and, lastly, sometimes principally or exclusively to males. In the case where the male sex seems to have entirely disappeared in consequence of prolonged parthenogenesis, there still reappears from time to time a male among a great number of individuals.

M. Adler seeks to explain the origin of the alternation of the two different annual generations among the Cynipidæ. He assumes that at first there was probably only one generation a year, and subsequently two identical generations. The modifications produced later on in these two generations are to be attributed to the influence of external vital conditions. Among the first must be placed changes of climate; for we know, chiefly from the observations and experimental researches of M. Weismann, that the influences of different climates are able to give the first impulse to the changes which lead to the separation of two generations. As for the degree of the modifications, it arises from a factor whose importance we cannot well appreciate; the special organization of a species presents sometimes a great disposition to vary, sometimes a tendency to preserve its characters; so that there is sometimes scarcely any difference between the two alternate generations of the Cynipidæ in spite of the most varied ex-

ternal conditions (*aptera-terminalis*), whilst at other times there are striking differences (*renum-crustalis*).

Whilst admitting that the two generations may have been originally identical, one is led to ask, which of the two now existing corresponds to the original form, or at least resembles it most. M. Adler believes that it is the agamic generation that represents this original form; if it is not identical with it, it should at least be very near. This conclusion is deduced from the following facts:—

First, the parthenogenetic form exists alone in certain species.

Secondly, among the Cynipidæ there is no case known of a sexual form existing alone; all the sexual species are only known to us as a link in a cycle containing an agamic generation.

Without being absolutely convincing, the arguments of M. Adler have a certain value. To this we might add that, contrary to what we see in other Articulata in which parthenogenesis exists, the sexual generations are the summer broods, and the parthenogenetic generations producing females are those which hibernate. Now the analogies with other insects would lead us to suppose that the hibernating generation is the original, and that the summer generation is secondary*.

These provisional hypotheses will probably have to be much modified by later discoveries; but the researches of M. Adler will always be conspicuous as being a great advance in our knowledge of parthenogenesis, and be reckoned among the most patient and fruitful researches which have been undertaken on insects. A. H.

XXVIII.—*Note on* Wagnerella borealis, *a Protozoan.*

By C. Mereschkowsky.

When I described in this Journal† the interesting organism that I discovered in the White Sea, and named *Wagnerella borealis*, in honour of my master Prof. Nicolas Wagner, I had before me only a few specimens; and these were preserved

* See A. Weismann's 'Studien zur Descendenz-Theorie: I. Ueber den Saison-Dimorphismus der Schmetterlinge,' Leipzig, 1875.

† C. Mereschkowsky, "On *Wagnerella borealis*, a new Genus of Sponge nearly allied to the Physemariæ," Ann. & Mag. Nat. Hist. 1878, ser. 5, vol. i.; and "Etudes sur les Eponges de la Mer Blanche," in Mém. de l'Acad. de St. Pétersb. vol. xxvi. no. 7.